

Methods for Determining Wartime Medical Requirements

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13. ABSTRACT (Maximum 200 words) This briefing presents some results of our analysis of various methods and models that are used to determine wartime medical requirements. Our approach has focused on two key issues. First, we examined the requirements process, which really means understanding the main methods or tools that are used. The second key issue concerns the comparison of the requirements models used in the process. We identified three major objectives in the study plan. We identified three major objectives in the study plan. We would then examine current methods and models. We would then examine some proposed or future methods. Understanding the requirements for similar resources allows us to then state their respective strengths and weaknesses and recommend improvements.					
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Methods for Determining Wartime Medical Requirements

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May 1996

This briefing presents some results of our analysis of various methods and models that are used to determine wartime medical requirements. The sponsor of the study is N-931, RADM Dysart. The study officially started in November 1995, and we will complete it in September 1996.

Outline

- Study objectives
- Tasking and current focus
- Approach
 - Discussion of the requirements “process”
 - Comparison of requirements models
- Why do the requirements differ?
- What’s next?

Here’s a brief outline of what we’ll be discussing today. We’ll begin by describing the study’s objectives. We’ll turn to the specific tasking in the study, focusing on those tasks that pertain to this presentation. Our approach has focused on two key issues.

First, we examined the requirements process, which really means understanding the main methods or tools that are used, as well as the data inputs required. What may appear to be the same process can lead to different requirement numbers if some of the inputs—models and/or data—are not held constant among runs.

The second key issue concerns the comparison of the requirements models used in the process. The models may rely on many of the same inputs, but we wanted to explore why they often lead to very different sets of requirements. We’ll try to answer this, based on our work thus far. Finally, we’ll outline what we believe comes next in our analysis.

Study Objectives

- **Examine current and proposed methods that generate requirements**
- **Identify models' strengths and weaknesses**
- **Recommend improvements to the process for setting requirements**

We identified three major objectives in the study plan. We would examine current methods and models for determining wartime medical requirements. Once we understood the current methods, we would then examine some proposed or future methods. We've focused so far on a few models in use today. We'll briefly describe each model and the analytical approach we took to understand how it works. By understanding how each derives requirements for similar resources, we can then state their respective strengths and weaknesses and recommend how to improve both the requirements models and the process.

Tasks

- **Determine impact on requirements of planning factors and evacuation policies**
- **Examine current tools**
 - **Medical Planning Module (MPM)**
 - **LPX-MED (now Medical Analysis Tool, or MAT)**
- **Examine proposed tools**
 - **WARMED (Air Force database and simulation model)**
 - **MedModel (commercial simulation model)**

To accomplish these objectives, we outlined three tasks, the first two of which are relevant to this presentation. The tools or models used to determine requirements are simplifications of a very complex process. The models introduce assumptions representing the effects of such factors as casualty rates and treatment times in theater and in CONUS. We'll refer to variables used to represent important assumptions or policies as planning factors. An example of a planning factor might be the wounded-in-action (WIA) rate or the disease, nonbattle injury (DNBI) rate. In addition, elements of the theater evacuation policy are also introduced through the use of planning factors.

One of the project tasks is to find out which factors are most important and how sensitive derived medical requirements are to small changes in these factors.

We've been examining the details of two models currently used in the requirements process: the Medical Planning Module (MPM) and the Medical Analysis Tool (MAT), formerly the External Logistics Processor-Medical Module (LPX-MED). We will examine other models and methods, such as those listed in the third bullet, in the future.

Study Approach

- **Focus on two questions**
 - What is the process underlying requirements determination?
 - What are the critical planning factors?
- **Answer by examining models in detail**
 - In one case, this meant developing our own PC version

For this presentation, we've focused on two questions. First, what is the process that determines wartime requirements? To answer this question, we must understand the various models that are used and the specific inputs they require. Understanding the process can help clarify why different answers sometimes result from what is perceived to be the same question and the application of the same methods and tools.

The second question is one we alluded to earlier: what are the critical planning factors? Which factors are most important, and what kinds of effects do they have? One important factor is also probably the most difficult to measure accurately—namely, the casualty rates expected on the battlefield.

We may not be able to say very much about the accuracy of the planning factors assumed, but we are interested in understanding their relative importance in the determination of medical requirements. We believe the best way to quantify the effects of individual planning factors is to run the models assuming different factors and policies in place and measure the corresponding change in requirements.

Requirements Process

- **Complex, with requirements depending on many factors**
- **There is only one approved model**
 - But, MPM is slated to go away
 - Joint Staff wants to use new version of LPX-MED
- **All models are scenario and assumption driven**
 - Data input process is not user friendly
 - Requires experienced users and careful documentation
- **GAO looked at differences between CINCs' and 733 req's**
 - CINC plans for Korea and SWA predicted twice as many casualties as 733 study and over twice the required beds

The overall process of determining requirements is complex. Many factors affect the ultimate number of resources required. At present, the only DOD-approved model is the MPM. Although there is some debate on its replacement, it seems fairly certain that it will be MAT. In the meantime, however, MPM will continue to be used. All of the models' results are sensitive to the data inputs. In many cases, the planning factors' relative importance may not be well understood by the medical planners who need to use them.

As an example of the sensitivity of a result to different assumptions and planning factors, the requirements planning process appears to lead to one set of requirements when calculated as part of the OPLANS, but another set when computed in Washington for programming and budgeting purposes.

The General Accounting Office (GAO) examined the differences between the 733 study's requirements and those derived by the CINCs. The CINCs' requirements were more than double what was found in the 733 study. The reasons for the difference are that the 733 study assumed (1) a smaller PAR, (2) significantly lower DNBI rates, (3) a less intense warfight for the Korea scenario, leading to fewer WIA casualties, and (4) quicker movement of patients out of the CONUS military hospital system. The same methods and model were used, but differences in inputs led to different results.

Critical Planning Factors

- **Population at risk (PAR)**
 - Taken directly from the total phased force deployment data (TPFDD)
- **Casualty rates**
 - Disagreement about rates and estimation methods
- **Lengths of stay**
 - Models differ in level of aggregation
- **Evacuation policy**
 - Evacuation delay before transport out of echelon
 - Evacuation rates to next echelon

We mentioned earlier that there are many factors that can potentially affect medical resource requirements. This slide cites four of the most important planning factors: the PAR, casualty rates, average lengths of stay (ALOS), and the evacuation policy.

The PAR comes directly out of the TPFDD, but can change over time with losses of military personnel. Casualty rates, both WIA and DNBI, will obviously affect the demand for resources and probably are the most difficult factors to derive. Most participants agree that there is a need for more standardization across the services and a clearer understanding of the sources of the rates. The lengths of stay in the medical facilities before a patient returns to duty will directly affect resource consumption. Over time (i.e., from WWII to present), planners have assumed that these values have generally decreased, which leads to lower medical requirements. Even though values have fallen, questions remain on whether lengths of stay should be lower still and how they vary by condition.

The last factor listed represents the evacuation policy in place in theater. To quantify the effect of evacuation policy on medical resources, two variables are probably most important: the time it takes before patients can be moved to the next echelon and the percentage of patients who need care longer than the evacuation policy in place at that echelon.

Requirements Models—Background

- Current process in state of flux
 - MPM is the only DOD-approved tool for medical planning and programming
 - But, going away in 1996 (? when GCCS goes on-line)
- Joint Staff recommending LPX-MED/MAT, but services not ready to sign on
 - LPX-MED analysis of 733 Update TPFDD
 - Much lower bed requirement than MPM
 - Bed mix very different, too
 - e.g., Navy requires 42% of echelon 3 beds be ICU, but fleet hospital has only 16% ICU beds

At present, the MPM is the only DOD-approved tool for medical planning and programming, but it is scheduled to go away sometime in 1996 when the World Wide Military Command and Control System (WWMCCS) is replaced by the Global Command and Control System (GCCS). The Joint Staff wants to replace it with MAT, but the three services want to ensure that the model is validated against the MPM before they accept it for determining their medical requirements.

Early runs of LPX-MED/MAT of the 733 Update TPFDD calculated significantly different requirements than MPM. MAT led to lower overall bed requirements than MPM, as well as a very different bed mix required in theater. The slide presents an example applied to the Navy's fleet hospital. According to the MAT runs, the Navy required that 42 percent of its third echelon beds be for intensive care, but the currently configured fleet hospital has only 16 percent of its beds so configured.

Thus, there are smaller numbers, and a different mix of beds required for wartime planning. This result, if it holds up in later runs, would, in turn, lead to a different mix of other medical resources that are directly linked to the type of beds required.

MPM

- **First develops a PAR from JOPES TPFDD**
 - **Breaks the PAR into three operation zones (OPZONES)**
 - **Further divided into combat and support categories**
 - **Applies combat intensity rates evenly to all PAR within an OPZONE (lower for support forces)**
 - **Method felt to overstate casualty projections**
- **Other planning factors applied to casualties to derive resource requirements**
 - **Evacuation policies**
 - **Average lengths of stay**

The next three slides present an overview of the three models used, or in contention for use, in the requirements process. The first model is the MPM. It has the capability of reading a TPFDD from the Joint Operations Planning Execution System (JOPES) and it also calculates the population at risk over time. There are three OPZONES, the third representing CONUS. It divides the forces within OPZONES 1 and 2 into their combat and support elements and allows each to have different casualty rates applied. One characteristic of the MPM is that combat intensity rates can vary day-to-day, but it applies these rates evenly to all of the PAR within that OPZONE (although a lower intensity level can be applied to support forces). A second important characteristic of MPM is that it calculates resource requirements at a fairly high level of aggregation. For example, it breaks the bed requirement into only two categories—medical and surgical.

Resource requirements depend on a number of factors other than WIA and DNBI rates. Important ones include those related to evacuation policies, such as evacuation delay times and the percentage of patients whose length of stay is expected to be larger than the evacuation policy in place at that OPZONE. These are the kinds of planning factors we can change in the model and determine how large the effect on bed requirements would be.

Medical Planning and Execution System (MEPES)

- **Designed to replace MPM**
- **Similar calculator-type model**
 - **MEPES allows planner to sector OP areas into more than 3 OPZONES**
 - **Allows as many as 6 sectors within each of 5 OPZONES**
 - **But, DNBI rates tied to combat intensity rates by OPZONE**
- **Unlikely ever to be used in requirements process**

Complaints that MPM was too simple in that it applied casualty rates to the PAR within an OPZONE led to the development of another requirements generator—MEPES. The major distinction between the two models is that MEPES allows the medical planner to “sector” the operational areas into many more than three OPZONES and apply different casualty rates to each. This is more realistic than applying the same rate to everyone. As George Kuhn of the Logistics Management Institute has pointed out, there are major differences in battlefield combat intensities depending on the location and size of the forces actually employed in battle. One unit can be engaged in heavy combat while another one fairly close by may not be engaged at all.

Although MEPES allows for sectoring the battlefield and applying different combat intensities to each sector, it has one potential drawback: disease and nonbattle injury rates are tied to the combat intensity in the OPZONE.

Regarding MEPES, perhaps the most significant issue for this study is that, although it is not officially “dead” as a medical planning tool, few believe that MEPES in its current form will ever be used. It seems clear that MPM will be used until the next tool, MAT, is officially declared its replacement. We turn to it next.

LPX-MED/MAT

- **Course of action model**
 - User must define network and resources ahead of run
 - Model determines if resources are sufficient
 - Model identifies choke points, shortfalls
 - Simulate theater provision of medical treatment
- **Disaggregate model**
 - User defines combat units, specific medical facilities, evacuation assets and paths
 - Allows for sectoring
 - Arrays casualties by type and severity

LPX-MED/MAT is a model that simulates the flow of patients through the medical network and determines whether the resources provided are sufficient. To run LPX-MED/MAT, the user inputs scenario information to generate a flow of patients and the medical resources available at each echelon. LPX-MED/MAT is a disaggregate model. Because the model is disaggregate, it can accommodate sectoring, and the user can input different combat intensities for each unit. In addition to identifying the combat units and combat intensities, the user defines the specific medical facilities at each echelon, and the evacuation assets and paths that connect the medical network. As the model flows patients through the medical system, it arrays them by casualty type and acuity level and directly accounts for the fact that different patients require different types and amounts of care.

Comparing MPM and LPX-MED/MAT

- Conceptual as well as more subtle differences
 - Requirements calculators (MPM) versus course of action simulator (LPX-MED/MAT)
 - Degree of aggregation assumed
- Poor documentation about assumptions and methods
 - LPX-MED documentation is better than MPM
 - MPM was developed a long time ago
 - But, only true calculator around
 - CNA believes MAT can't be "validated" without careful comparison of same scenario

This slide summarizes some of the major differences between the two main models. Some differences are conceptual. MPM (and MEPES) calculate requirements based on the PAR and various planning factors. They rely on applying some assumed average rate to the PAR or evacuees to ultimately derive a medical resource requirement. LPX-MED/MAT wasn't developed to derive requirements, but rather to perform a simulation and then evaluate how well the resources put in place would do. The model can be run deterministically or as a simulation. It has some advantages over MPM in that it disaggregates many of the important variables. For example, rather than three types of casualties—WIA, disease, and NBI—it has 24 "clusters" of casualty types, with varying acuity levels and lengths of stay.

MPM was developed many years ago, and the documentation describing the model and how it works is poor. MAT has the decided advantage here because Booz-Allen, the developer of LPX-MED/MAT, continues to support and refine it. We have found the Booz-Allen representatives to be very helpful when we've had questions about how it works.

Nonetheless, MPM continues to be the only true requirements calculator in use today. Before moving to MAT to derive requirements, we believe work needs to be done comparing the results of the two models using similar patient streams and the same wartime scenarios.

Casualty Estimation

- Conceptually the same
 - Drivers are the PAR, casualty rates, combat intensity
- LPX-MED allows sectoring, MPM does not
 - Capability to sector probably lowers average casualties, but increases peaks
 - LPX-MED is more flexible than MPM
 - Network can change to reflect new battlefield tactics
 - But, it's not easy to do

Conceptually, both LPX-MED and MPM estimate the number of casualties in a period by multiplying that period's PAR times the casualty rate for the given level of combat intensity. Both models allow for casualty rates to vary with combat intensity, by type of casualty (WIA versus DNBI), and type of unit (combat versus support). Given the same scenario and assuming full troop replacement, the models produce virtually the same casualty stream, the only differences apparently due to rounding.

The models differ, however, in their degree of aggregation and, therefore, the level of scenario detail they can accommodate. MPM is an aggregate model that treats the battlefield as a single sector with only one level of combat intensity in a given time period. In contrast, LPX-MED can allow combat intensities to vary across units during a given time period. In general, battlefield sectoring lowers the average casualty level but increases the peak number of casualties in a given sector. Because LPX-MED can handle varying unit size and combat intensities, it is more flexible and can better accommodate the new battlefield tactics in which troops may deploy in small, dispersed teams. However, even LPX-MED is not well suited to handle rapid troop movements or a rapidly changing medical network configuration.

Evacuation Policy

- Both can make tradeoffs between theater resource requirements and evacuation assets
- MPM evacuates patients according to a set schedule
- LPX-MED evacuates patients individually
 - Rotary wing/ground: on demand with random wait time
 - No minimum number of evacuees
 - Patient leaves bed when placed in evacuation queue

Both models trade off evacuation assets and theater medical assets. MPM evacuates patients according to a set schedule. This schedule is determined by the evacuation delay and the percentage of patients whose treatment times are greater than the stated theater evacuation policy.

In LPX-MED, when a patient arrives at a facility, the model evaluates whether there are sufficient resources to treat the patient within the allotted time constraint or whether the patient needs to be evacuated for treatment. The evacuation process is relatively "smooth." For rotary and ground evacuation, patients only have to wait for evacuation assets to return from shuttling the last load of patients to the destination facility. To this calculated wait time, the model adds a random wait time to account for the fact that delays do occur. At higher echelons, the model evacuates patients according to the set schedules of the fixed-wing assets. The model does not require a minimum number of evacuees and will send an asset to evacuate one patient. In addition, the model counts patients as having left their beds once they are ready to be evacuated.

Treatment Process

- The models are very different
- MPM has three types of casualties
 - WIA, disease, and NBI
- LPX-MED disaggregates casualties into 24 categories
 - Acuity randomly assigned (5 levels)
 - Assigns bed hours for each phase of care (i.e., triage, OR, ICU, ward) at each echelon (3, 4, or 5)
 - Triage only at echelon 2
 - Evacuate to CONUS (echelon 5) those who need recuperative care

MPM divides casualties into three types, whereas LPX-MED specifically models variation in casualty type and acuity level. LPX-MED classifies casualties into 24 categories and 5 acuity levels. The model derived the 24 casualty categories by aggregating from the more than 300 patient condition codes in the DEPMEDS database. The model assigns casualties to casualty categories based on the probability of occurrence for that scenario. The model randomly assigns an acuity level from 1 to 5. Based on the casualty type and acuity level, the model assigns the required level of treatment (staff, supplies, and bed hours) for each phase of care (i.e., triage, OR, ICU, ward) at each echelon. Echelon 2 is the model starting point and, at that level, only triage is provided to patients. Once the required care at an echelon is completed, individuals are ready for evacuation. Those who require recuperative care are evacuated back to CONUS as soon as it is feasible.

CNA Approach to Model Comparison

- CNA was provided with LPX-MED program
- We had to develop our own version of MPM
 - Allows us to carefully maintain quality control of the run
 - Within the same model
 - Change planning factor and deduce effect
 - Across models
 - Determine how same patient stream can lead to different resource requirements
 - Added benefit: Navy (and others) would have simpler version of MPM to perform “what-ifs”

Performing these comparisons between the main two models in use today was a central focus of our analysis. It became clear to us, however, that without being able to run MPM, it would be difficult to say how it really calculates requirements and then compare its results to those derived from running LPX-MED. We were given MPM's underlying equations and decided to build our own version. Although this may seem like a large task, we felt the advantages of having a model to run were well worth spending the time required to create it. Having our own version allows us to maintain quality control of the model runs. In some cases, we would want to run the same scenario, but vary the assumed value of one or more planning factors. This would allow us to determine the relative effects on requirements of these factors. In other cases, we can compare and contrast the numbers derived from MPM with the same scenario run for LPX-MED/MAT. As one example, we can determine how the same patient stream can lead to different sets of resource requirements.

We've created two new versions of MPM: a spreadsheet version and a computer program written in Visual Basic that is tied to a spreadsheet. The advantage of the program version is that it should be easier to modify and then run again. Either version provides the interested user with a simpler version of the current MPM for performing what-if analyses.

Does It Work?

- Yes and no
- Ran 733 MRC-West for Navy
 - Simplest of the services' runs
 - Should be "easy" to fine-tune
- What's the problem?
 - Original 733 MPM output presents peaks and averages over ten-day period, not daily values
 - Some variables match precisely, others are "close"
 - ☐ We're not satisfied with just close in calculator-type model
 - ☐ Documentation is of limited help

Of course, any new version of a model should be tested and carefully compared to the previous or official version. We did that and found some problems. We used the simplest scenario from the 733 study of a few years ago—the MRC-West for U.S. Navy forces. Our version of the MPM doesn't read the TPFDD directly; it begins with the PAR listed in the 733 study. The MPM performs calculations daily, but only reports the values for the ten-day period. In some cases, it reports the last day's value (e.g., for the PAR); for others, it reports the ten-day peak and average values (e.g., for evacuees or bed requirements). The simpler the case (i.e., one with a smaller PAR or with fewer changes over time in combat intensity levels), the easier it should be to match our results to what was reported in the 733 study.

In many cases, based on what the original MPM equations imply as well as what we believed made sense analytically, our results match the original version precisely. For some other variables, such as beds, we derived values that were usually close, but not the same. We found after some experimentation that it was easy to derive slightly different values because of rounding rules and the like. Nevertheless, we believe that, once we use the same rules and planning factors, we should be able to match all values precisely in a deterministic calculator model like MPM. One problem is that the MPM's documentation of the input values is poor. We may be using the wrong values.

Can We Use It?

- We believe so
 - Examine differences in bed requirements from base case
 - Need to “fine-tune” it further
- Points out obvious problem with current MPM
 - Few people familiar with equations and data inputs
 - Matching values to 733 implies lots of “tinkering”
 - Our version easy to change if anyone can tell us what’s wrong
- Largest differences from 733 values
 - Theater evacuations and CONUS bed requirements from C+40 to C+70

Despite the differences that remain, we believe that we can use our version of MPM to examine the effects on bed requirements that result from a change in some planning factor. We would like to continue getting our version to match the 733 run, but we also believe that the problems we’ve encountered point to several problems with the MPM used today. Few people who use it really understand its underlying equations and how it takes input values and calculates medical requirements. We also believe that it is quite likely that the values derived in 733 were based on different planning factors than the study reports. If that were the case, there may have been good reasons for making the changes, but they should have been clearly documented. Whatever the reasons for the differences between our output and the 733’s, including a mistake on our part either in concept or use of a planning factor, we should be able to change our model easily and rerun it.

We found the most difficult variables to match were the OPZONE 2 evacuations and the CONUS bed requirements. What was most frustrating was that we could match the bed requirements in the early period and at the end of the run, but not in the middle periods, from about day C+40 through about C+70. It seems likely that the value for the average length of stay during this period was changed, but we couldn’t find a clear accounting of what the change was.

Percentage Change in Peak Values From Doubling Combat Intensity

	WIA	Evacs		Beds required			
		OPZ 1	OPZ 2	OPZ 1	OPZ 2	CONUS	Total
Case 1: Double WIA and KIA rates	96	66	77	54	64	64	61

The next two slides provide several examples of running MPM to determine the effects on key variables due to changes in one or more planning factors. Rather than report the absolute levels of each variable in each case, we report the change from the base case, which means relative to the values associated with our version of the 733 MRC-West requirement for the U.S. Navy.

The first case corresponds to the values derived when we doubled both the killed-in-action (KIA) and WIA rates. It may seem strange that we don't find that the number of WIA doubles as well, but that is simply due to the rounding rules the model relies on. The PAR is relatively small, as are the WIA rates over time, and rounding has an effect. One finding is that neither evacuees nor beds required at any OPZONE increase proportionately with the WIA. One reason is our reporting the effect on peak requirements, which for beds is probably most important for determining the overall requirement. Even though the number of people wounded almost doubles, they flow through the system in such a way as to increase the overall bed requirement by only about 60 percent.

Percentage Change in Peak Values from Changes in Delay and ALOS

	WIA	Evacs		Beds required			
		OPZ 1	OPZ 2	OPZ 1	OPZ 2	CONUS	Total
Case 2: Evac delay at OPZ 1 falls to 1 day	0	0	0	-44	0	-9	-17
Case 3: Evac delay at both OPZs falls to 1 day	0	0	0	-44	-54	-9	-33
Case 4: Change evac delays, but increase ALOS	0	0	0	-44	-51	3	-27

On this slide, we report a somewhat more complicated set of cases. The first two pertain to the effects of smaller evacuation delays. In the first case presented on this slide, we reduced the evacuation delay time from OPZONE 1 from 4 days to 1 day. The number of wounded remained the same, and one effect was simply to reduce the number of OPZONE 1 beds required by about 44 percent. We found no effect on OPZONE 2 beds, but a 9-percent reduction in CONUS beds.

Before we explain why we believe this occurs, let's turn to the next case, case 3. In addition to reducing the delay at OPZONE 1, we also reduced the delay time at OPZONE 2, which falls from 6 days to 1 day. The same 44-percent reduction in beds occurs at OPZONE 1, and the same 9-percent reduction occurs in CONUS, but now there is also a 54-percent reduction at OPZONE 2.

After observing the results, we realized that moving people out more quickly doesn't ensure that they ever make up for the reduced length of stay resulting from the shorter evacuation delay. In other words, average length of stay (ALOS) at an OPZONE appears to be independent of the evacuation delay time. If you are moved out more quickly, only by increasing the ALOS at the next echelon can we ensure that the total time spent in a bed is constant. We've done that in the last case and found a smaller reduction in OPZONE 2 beds and that a slightly higher number of CONUS beds would be required.

Resource Requirements

- MPM calculates requirements numbers
- LPX-MED did not, it evaluates those the user enters
 - Joint Staff likes LPX-MED and pushed Booz-Allen to use it to determine requirements
 - So how do they do it?
 - ☐ Provide the medical network with unlimited resources
 - ☐ See how much medical capability is required as patients flow through the system
 - Future version of MAT may include requirements calculator based on MPM or MEPES

MPM calculates requirements, whereas LPX-MED evaluates whether a given set of requirements is sufficient. The Joint Staff wants to use LPX-MED as a medical requirements model. To do this, they have requested that Booz-Allen run the model, assuming availability of an extremely high level of medical resources, and then evaluate the level of resources actually used in the simulation. To date, Booz-Allen has accomplished this by inputting a single "megafacility" at each echelon and evaluating resource use under this conceptual medical network. Running the model with a medical network that contains only a single highly resourced facility at each echelon smoothes over the complexities and lack of substitution that exist in a realistic network. LPX-MED originally was designed to address these complexities by simulating the medical network. When the model is run in an aggregate mode, it has no mechanism to account for the rigidities and complexities of the medical network.

Intended LPX-MED Analysis

- **Run the same 733 scenario**
- **Derive bed requirement**
- **Break down differences in beds from what was derived using MPM**
 - **What's due to underlying model assumptions?**
 - **What's due to differences in assumed planning factors?**

This slide shows what we intend to do with LPX-MED. We want to run the same 733 scenario through the model (i.e., MRC-West for the Navy), with the same PAR, and, therefore, the same patient stream. Assuming the megafacility approach that we described in the previous slide, we will derive a set of bed requirements. Our goal is to determine all of the reasons that lead the two models to different sets of requirements. For example, what percentage of the difference in requirements is due to differences between the models in their respective evacuation delays, average lengths of stay, or whether the patient is in a bed while awaiting evacuation to the next echelon of care?

Why Do the Requirements Numbers Differ?

- LPX-MED simulates a “perfect world”
 - Patients are evacuated when clinically ready
 - Patient time at facility exceeds the time in a bed
 - Does not account for “fog of war”
 - Result of these factors is fewer in-theater beds
- CNA analysis has been delayed
 - We discovered a “bug” in LPX-MED
 - We are working with Booz-Allen to identify and fix the problem

Our preliminary analysis suggests that the main reason LPX-MED calculates a lower in-theater bed requirement than MPM is because it simulates what we’ve termed a perfect world. Events proceed smoothly and evacuation assets arrive on schedule (although there still may be random delays). But, there is no built-in delay, so patients are evacuated when their clinical treatment is completed. In other words, the time a patient spends in a bed is only as long as the time it takes to treat him. If he’s waiting for something other than treatment, such as for an evacuation asset, he’s not counted as using a bed.

In contrast, MPM relies on planning factors that correspond to an expected delay and the proportion of patients who require care longer than the stated evacuation policy from that operation zone. After MPM calculates bed requirements, a dispersion factor is applied to account for the “fog of war.” This dispersion factor increases bed requirements by an amount ranging from 11 percent in CONUS to 25 percent in OPZONE 1. In contrast, LPX-MED has no dispersion factor.

Our analysis of LPX-MED/MAT was only beginning when we ran into a problem. We discovered a flaw in the way it calculates bed requirements. We’re currently working with Booz-Allen to identify the problem, determine how serious it is, and how to fix it. Once that’s done, we can return to our analysis and comparisons with MPM.

Where Do We Go From Here?

- **CNA will continue to identify the key variables that affect beds and other resources in both models**
 - MPM uses averages
 - LPX-MED generally disaggregates
 - Determine when the averages differ
 - Determine when variation (LPX-MED only) matters
- **Focus on differences in key variables**
 - Quantify effect on requirements
- **Recommend changes to model or procedures**

We will continue to explore how key variables affect bed requirements and other resources in LPX-MED and MPM. However, the problem we have encountered in how LPX-MED is assigning bed days has slowed our analysis of the differences between the two models.

To compare the models, we are running them using the same scenario (the 733 scenario), and, where possible, we are setting all input factors to the same values. We are identifying and quantifying the impact of the key variables by changing input values and observing how these changes affect resource requirements in the two models. This process will identify the model drivers and clarify the sources of difference between the models. We will use this information to recommend potential improvements to the models and how they can best be used in the future.

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